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ABSTRACT

Reported are results of a study that investigated the effects of teacher training strategy on science activity lesson teaching behaviors of preservice teachers. The relationship between teaching behaviors and student achievement was also investigated. Preservice teachers (N=43) enrolled in elementary, middle, and secondary school science instructional methods courses were introduced to the activity lesson instructional behaviors. Two experimental groups of teachers then viewed and analyzed video taped model activity lessons, using the Science Laboratory Analysis System (SLAS). A control group received no further instruction beyond the initial introduction to the activity lesson behaviors. Behaviors of each preservice teacher were assessed on two science activity lessons, one taught to peers in a micro-teaching situation and one taught to a class of public school pupils. Pupil achievement was measured with pre- and post-tests based on the lesson objectives. Results include the findings that both experimental groups used significantly more of the 28 behaviors coded with SLAS than did the control group, and a significant position correlation was found between teaching behaviors and pupil achievement. (CS)

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THE EFFECTS OF BEHAVIOR MODEL ANALYSIS ON TEACHERS' BEHAVIORS DURING SCIENCE ACTIVITY LESSONS

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INTRODUCTION

Providing an opportunity for students to experience science and participate in the process of inquiry has become a concern for many science educators. Though the specific nature of the lessons within which manipulative materials are used varies greatly, the basic organization and managerial procedures which facilitate student-material interactions are relatively consistent.

Background

Sendelbach and Smith (1980), in an ethnographic investigation of a science activity lesson, found that a teacher's ability to engage students in the manipulation of materials was attributable to the procedures by which the activities and transitions were implemented. Lessons were carried out through the teacher's continuous monitoring of the following classroom procedures: entering, introduction, beginning, instructions, materials distribution, working, cleanup and ending transition. Teacher behaviors related to the functioning of these procedures should then be considered the appropriate teaching behaviors for a science activity lesson.

"Traditionally, science teacher training in methodology of teaching has implicitly or explicitly included the acquisition of particular skills thought to be related to student performances

in science classes" (Koran, 1977 , p. 89). If science educators value activity or laboratory experiences for public school pupils, teachers must be trained to implement such lessons. However, the training strategies used to facilitate preservice teachers acquisition of such skills vary. One such training strategy, a concept-based training strategy, describes a procedure in which the trainee acquires the concepts of specific teaching behaviors (Gliessman, Pugh & Bielat, 1979).

Concept Learning

A concept is defined as a class of entities that have the same relevant or defining characteristics (Gagne, 1970). The characteristics of teaching behaviors which are appropriate for a science activity lesson can be considered as concepts. Merrill and Tennyson (1977) contend that a student has learned a concept when he can correctly identify the class membership of an event. They suggest that the procedures for teaching a concept are:

1. Present a definition--identify the critical attributes;
2. Provide an expository presentation--sets of matched example/nonexample pairs;
3. Provide attribute isolation--help for discriminating each example and nonexample;
4. Provide inquisitory practice presentation--examples and nonexamples accompanied by feedback;
5. Test for correct classification.

As noted above, the concept teaching procedures described require the presentation of both examples and nonexamples. Research has been done regarding the relative effects of positive only, negative only and mixed positive and negative examples on concept learning yielding various results (Fryatt & Tulving, 1963; Hovland & Weiss, 1953). Smoke (1933) reported that a concept

may be learned from either positive instances only or both positive and negative instances. He also reported that while the time required to learn a concept was the same for both positive only and positive and negative mixed instances, the subjects preferred the latter. Additionally, subjects learning from mixed instances tended to be more accurate.

Teaching Behaviors as Concepts

Application of the procedure described for concept attainment to the concept of appropriate science activity lesson behaviors could be accomplished through the use of verbal descriptions and examples (or models) given by the instructors in the teaching methods class or through the additional use of an observational learning situation.

Incorporation of observational learning into a concept based strategy for training teachers to use appropriate activity lesson teaching behaviors requires more than the provision of teacher models. Koran, Koran and McDonald (1972) found models which included both teachers, students and their interactions to be more effective than models showing teachers only. The inference was made that the student component of the model served as a source of vicarious reinforcement to the observer. Also, discrimination may be aided through the use of an observational instrument which focuses the observer's attention on the appropriate behaviors (Yeany, 1977a).

The final step in the five-step procedure described by Merrill and Tennyson (1977) for teaching a concept, is to test for concept attainment. A written, paper and pencil test could

be used to assess concept attainment. However, a positive and significant correlation has been established between teaching behavior concept attainment scores and teaching behavior exhibition scores for questioning behaviors (Gliessman, Pugh & Bielat, 1979). Since the concept of a teaching behavior assumes practical value only when a teacher is able to use the behavior, an assessment of the subject's ability to exhibit the behavior serves as a more appropriate test for concept attainment.

Teaching Behaviors and Pupil Achievement

Ultimately, the goal of teacher training is to influence the learning of pupils in the classrooms. If the training strategy is effective, it should cause teachers to exhibit the desired science activity lesson teaching behaviors. If the teaching behaviors are truly appropriate for facilitating learning, the interaction between the teacher's behaviors and the students' behavior should have positive effects on the pupils' achievement.

Purpose and Rational

The purposes of the study were to investigate the effects of a teacher training strategy on science activity lesson teaching behavior of preservice teachers and to measure the relationship between these behaviors and science achievement. The treatment training strategy involved the analysis of either positive (correct) or a combination of both positive (correct) and negative (incorrect) teacher models. The video-taped teacher model exemplified teacher behaviors during science activity lessons.

The teaching behaviors had been previously described in class by the instructor. Correct analysis of the teacher behaviors was programmed into the video-tapes, supplying a comparison rating for the analysis performed by the preservice teachers.

Teaching behaviors described as approprieate for science activity lessons are assumed to be positively associated with pupil achievement. Extending this line of reasoning, it is reasonable to assume that pupils taught by preservice teachers exhibiting high levels of appropriate teaching behaviors should exhibit high levels of achievement. The testing of this assumption was also a part of the study.

The following research questions were asked:

1. Do variations in model analysis training strategies affect the teaching behaviors of preservice teachers?

2. Do variations in model analysis training strategies affect the achievement of pupils taught by preservice teachers?

3. Do preservice teachers of different preparation levels (elementary, middle school, secondary) exhibit different teaching behaviors?

4. Are the effects of model analysis training strategies consistent across preparation levels as measured by the teaching behaviors exhibited by preservice teachers?

5. Is there a relationship between the preservice teacher's teaching behaviors and pupil achievement?

6. Are the teaching behaviors exhibited by preservice teachers the same for micro-teaching as for public school teaching?

PROCEDURES

Sample Selection

The 43 preservice teacher subjects of the study were all students enrolled in science education teaching methods courses for either elementary, middle school or secondary school. The methods courses included assignment to and regularly scheduled participation in a public school class.

Since the experimental treatment occurred through assignments outside of whole class instruction, it was possible to achieve random assignment of subjects without adjusting original class structure.

Training Materials

The materials used for training subjects were designed specifically for this study. The instructional packets which contained printed materials and a video-tape cassette were made for the experimental treatment groups. Video-tapes of teacher models that coordinated with subcategories of the Science Laboratory Analysis System (SLAS) were produced. Instructional packets for the control subjects were produced without using any type of teacher model and without using the SLAS or referring to the teacher behaviors.

Science Laboratory Analysis System

The SLAS is a systematic observation schedule which was constructed by the researcher for use in this study as a means of measuring classroom behavior of teachers.

Medley and Mitzel (1963) define a "sign observation" system as a listing of acts, behaviors or incidents believed to be important, which may or may not occur, and the only items encoded are those on the list. The SLAS was constructed as a "sign" instrument. Science activity lesson teaching behaviors listed on the SLAS are those believed to be associated with a well managed lesson. Determination of the behaviors was based on an analysis of personal experiences and observed lessons. Validity of the behaviors listed on the SLAS was determined through a logical analysis by a panel of science teacher educators. The judgment of the panel was that the listed behaviors validly describe appropriate teacher behaviors for a science activity lesson. Predictive validity was later assessed within the study by measuring the correlation of the teaching behaviors to pupil achievement. The 28 behaviors listed on the SLAS are classified into five sections: seven introduction behaviors, five direction giving behaviors, four equipment related behaviors, seven activity management behaviors and five summary behaviors. Instruments which have been used for describing teacher behaviors in a laboratory lesson have emphasized verbal interactions. The SLAS includes organization as well as interaction behaviors since organization of pupil movement and meterials precede or accompany interaction behaviors. The behaviors are as follows:

Introduction

1. The class is steeled before the teacher starts the introduction (the teacher does not talk over student conversations).

Teacher focuses student interest by:

2. relating the lab to past or future class experiences;

3. relating the lab to past or future real life experiences;
4. introducing the lab problem;
5. presenting a short demonstration to arouse interest or raise questions about the activity to be performed in lab (e.g., a discrepant event).
6. Students are encouraged to make relevant contributions.
7. Teacher does not provide the solutions to the lab problem.

Giving Directions

8. Steps are given in a logical order.
9. The directions are sufficient for the students to understand with a reasonable number of questions.
10. Directions are presented orally.
11. Directions are presented in written form.
12. The teacher elicits or encourages students to ask questions.

Equipment

13. Enough equipment is available so all students are able to be involved.
14. All necessary materials are ready and in the classroom.
15. Unique materials are appropriately labeled so that they can be identified.
16. An appropriate system is used for distributing and acquiring equipment.

Activity Management

17. The teacher responds to student questions or needs within a reasonable amount of time.
18. As the students work, the teacher moves around the class to observe and interact with students.
19. The teacher guides students in finding their own solution to problems.
20. Potential problem situations involving materials are corrected before accidents occur.
21. Potential problem situations involving students are corrected before behavior disturbances occur.
22. Excursion activities are provided to keep groups which finish early on task.
23. The teacher has assigned tasks so that students know and perform assigned work roles within their group.

Summary

24. The teacher or students orally summarize the lab.
25. Students respond to specific questions about lab results.

26. The teacher leads students to relate lab work to class or everyday life experiences.
27. The teacher leads students to make generalizations about the lab problem.
28. The teacher leads students to identify new problems arising from the lab experiences.

The SLAS does not attempt to describe all behaviors exhibited by a teacher during a lesson and neither quantity nor quality of behaviors exhibited is described. This instrument simply provides a method for indicating whether or not the listed behaviors were exhibited by the teacher.

The Video-Tapes

The video-tapes of teacher models exhibited behaviors described within each subcategory of the SLAS. Tapes were produced in sets of five, one tape for each of the five SLAS subcategories. Two sets of video-tapes were made for each of the two experimental treatments (positive models only and combined positive and negative models). Elementary school teaching situations were used as the models for one set of tapes and a combination of middle and secondary school teaching situations were used in the second set. The teacher models were video-taped with their pupils in actual public school classrooms.

All training tapes followed the same format. Each tape began with a title naming the SLAS subcategory of behaviors which would be modeled in the scenes on that tape. The approximately six lesson segments, referred to as scenes, presented models of teaching behaviors for a particular SLAS subcategory. For example, for the SLAS subcategory Introduction, each scene on the 'Introduction' tape showed a teacher introducing a lesson and the students' reactions and interactions with the teacher.

After each scene there was a pause to allow time for the viewers to analyze the scene. After the pause, a correct analysis of the scene was given and in some cases explained by the narrator.

This study involved two experimental treatment groups; one viewed only positive teacher models, and the other viewed both positive and negative teacher models. The set of tapes for the positive model treatment included only positive models. Each scene in this set showed teachers using all or most of the behaviors listed on the SLAS even though the lesson context differed from scene to scene.

Tapes produced for the positive and negative experimental treatment included alternating positive and negative model scenes. A negative model is one where the teacher omits many or all of the behaviors described on the SLAS.

Printed Packet Materials for the Experimental Groups

Sets of five packets were made for each experimental treatment group, one packet for each of the five subcategories of teacher behaviors listed on the SLAS (Introduction, Giving Directions, Equipment, Activity Management and Summary). The printed materials for each packet consisted of the following: packet directions, instructions for using the SLAS, descriptions of the behaviors listed under the appropriate SLAS subcategory and multiple copies of the list of behaviors for the appropriate subcategory of SLAS and one vide-tape.

Materials for the Control Group

Instructional packets for the control subjects included

the following: packet directions, evaluation forms and either a film or set of curriculum materials. These materials assisted the students in examining the nature and quality of the science content presented in the films and curriculum materials. The purpose of this was to provide the control group with worthwhile placebo activities, but without exposure to teacher models.

Training Procedures

All subjects received in-class baseline training which included a verbal presentation of the appropriate teaching behaviors associated with the introduction, equipment, directions, management and summary of a science activity lesson. Though all behaviors cited on the SLAS were presented, the analysis system itself was not. The baseline training, approximately one hour in length, was given to intact science teaching methods classes. After the initial instruction, all the subjects were required to receive instructions for additional assignments to be completed outside of class. Each student was given one assignment. This assignment was one of the treatments of the study. After completion of the outside assignments, all subjects were required to plan and teach a science activity lesson to a small group of peers. This lesson, referred to as micro-teaching, was video-taped. All subjects privately viewed their own micro-teaching lesson. All subjects then taught a science activity or laboratory lesson to their assigned public school class. This lesson was also video-taped. The subjects tested their pupils' achievement associated with this lesson. The sequence and relationship of activities for all treatment groups are illustrated in a flow chart (Figure 1).

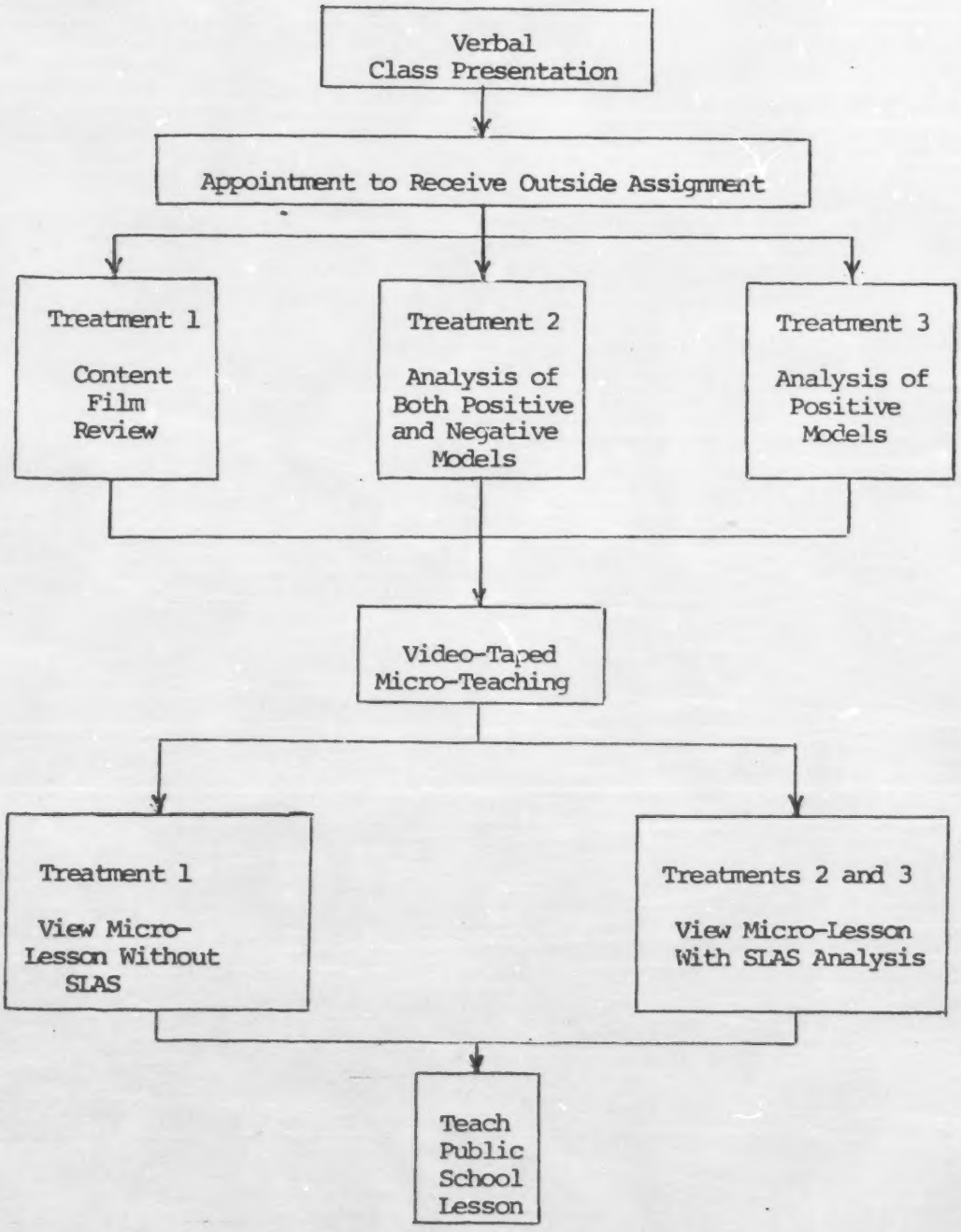

Figure 1. Flow chart of science activity lesson instruction for all subjects.

Dependent Variables

Two types of dependent variables were assessed in this study: (1) the behaviors of teachers, and (2) the achievements of pupils who experienced those behaviors.

Teaching Behaviors

A teaching behavior exhibited one or more times during an observation period was encoded with a check on the SLAS, but if the behavior was not exhibited no mark was made. The observation period was the length of one lesson. To facilitate score calculation, each behavior checked equaled one point and a score represented a point total.

Two observers were trained to use the SLAS. Initially they individually viewed and analyzed the model tapes produced for use in the model analysis training strategy treatment packets. Video-tapes of micro-teaching lessons taught by preservice teachers who were not subjects in this study were then analyzed by both observers until they were consistently in agreement.

Two lessons for each subject were analyzed by two observers. Each subject's micro-teaching lesson and public school lesson-teaching behaviors were analyzed via video-taped records of those lessons. Twelve teaching behavior scores were calculated on the basis of the SLAS for each subject: a total micro-teaching lesson score, a total public school lesson score and five subcategory scores for each lesson. All scores were based on the average of the two observers.

The question of reliability was addressed by application of generalizability theory (Cardinet, Tourneur & Allal, 1976).

Of interest was the suitability of the SLAS data to differentiate among treatment groups for the total SLAS score and for each of the five subcategories. The generalizability coefficients for this purpose were calculated on a five facet nested design, with teachers nested within treatment group. Coefficients presented in Table 1 indicate suitability of SLAS data for group differentiation.

(insert Table 1 about here)

Pupil Achievement

Pupil achievement was measured with multiple-choice pretests and posttests constructed by the individual preservice teacher. Tests were approximately eight items in length with items representing a range of cognitive levels. The tests were designed to assess the objectives for the public school activity lesson which lasted only one class period and was video-taped. Since the lessons were to be part of the pupils' regular class schedule, the topics and objectives were different for every lesson. This meant the items on every test were also different. In each class the same test was used for both the pretest and the posttest immediately following the lesson. This procedure was used to guard against the internal validity threat of testing. To validate the list of reported pretest and posttest raw scores, preservice teachers were also required to turn in the individual pupil's actual test paper.

Since subjects were teaching toward different sets of objectives, standardized gain scores were selected as the criterion for comparing pupil outcomes. Standardized gain scores are

defined as the amount of change in average pupil performance from pretest to posttest in coded standard deviation units (Yeany, 1977b). The score is calculated on class mean pretest and post-test scores. Since the class was used as the unit of analysis, one standardized gain score was calculated for each public school class.

Data Analysis

The data were analyzed by using a 3 X 3 fixed-factor design. Treatment and preparation level (i.e. elementary, middle school or secondary) served as the factors. Analysis of variance procedures were used to determine if differences existed which could be attributed to either of the factors. Post analyses were carried out through the use of Newman-Keuls procedures.

Correlated t tests were computed to assess differences between micro and public school teaching. Pearson Product Moment Correlation coefficients were used to examine relationships between the teaching behaviors and the pupil achievement. All data were analyzed through SPSS computer programs (Nie, Hull, Jenkins, Stanbrenner & Bent, 1975).

RESULTS

The model analysis training strategies produced significant differences in the exhibition of science activity teaching behaviors by preservice teachers. Model analysis strategy groups consistently performed significantly better than the control group on total behavior scores for both the micro-teaching and public school lessons ($p < .01$). The data are summarized in Tables 2, 3, 4 and 5. All subcategory activity lesson behaviors

(introduction, giving directions, equipment, activity management and summary) were also significantly better for the model analysis strategy groups (see Table 6). The post hoc analysis indicated that for all 12 behaviors, both positive only and positive and negative model analysis groups exhibited more appropriate behaviors than the control group, but there was no significant difference between the two model analysis groups.

(insert Tables 2, 3, 4, 5 and 6 about here)

Achievement differences were found in pupils taught by preservice teachers who experienced different treatment training strategies. Pupils taught by preservice teachers instructed with model analysis training achieved more than pupils taught by preservice teachers not instructed with model analysis training. The greatest difference, one standard deviation unit, was between pupils taught by control group teachers and pupils taught by positive model analysis group teachers. Tables 7, 8 and 9 summarize the data.

(insert Tables 7, 8 and 9 about here)

Results indicate that the preparation level of the preservice teacher was related to the types of behaviors exhibited in the micro-teaching situation for total teaching behaviors and two subcategory teaching behaviors: giving directions and equipment. The greatest differences occurred in the direction-giving behaviors (Table 10). Post hoc analysis indicated that middle school teachers performed better than elementary teachers on each of the three behaviors and that secondary teachers performed better than elementary teachers on giving directions.

There were significant interactions between training strategy and teacher preparation level for the micro-teaching behavior subcategories introduction ($F = 2.49$, $p = 0.06$) and equipment

($F = 2.35$, $p = 0.07$). However, even for these behaviors model analysis was more effective than training without models (see Figures 3 and 3).

(insert Table 10 and Figures 2 and 3 about here)

Positive correlations were found between pupil achievement and all public school lesson teaching behaviors. The Pearson correlation coefficients are presented in Table 11.

(insert Table 11 about here)

Comparison of micro-teaching lesson behaviors with public school lesson behaviors revealed only a small amount of difference between total behaviors exhibited in the two lessons (see Table 12). The subcategories where notable decreases occurred were: introduction, activity management and summary behaviors.

However, when the data were analyzed with the control group subjects separate from the model analysis groups, the control group's total behaviors exhibited decreased from the micro-teaching lesson to the public school lesson while the model analysis groups' total exhibited behaviors slightly increased (see Tables 13 and 14). Decreases occurred in all subcategories except Introduction for the control group. While for the model analysis groups a notable difference occurred in the increase of Introduction behaviors and the decrease of Summary behaviors.

DISCUSSION

This study addressed the question of whether variations in model analysis training strategies would affect the teaching behaviors of preservice teachers. While either type of model analysis strategy resulted in significantly more exhibition of appropriate teacher behaviors than did the strategy without model

analysis, there was no significant difference between the two types of model analyses. Two possible explanations for a lack of difference between the two models are: first, that only the positive models are causing the change in behavior and that the threshold number of positive exposures are presented in both model analysis strategies; or second, the sensory feedback provided by the model portrayals of negative pupil responses to the teachers' lack of appropriate behavior exhibition is equivalent to the feedback provided by the positive counterpart. Both model analysis groups viewed the same number of model scenes. If all scenes exert influence on the subject, and the total amount of influence is the same for both groups, then the amount of influence exerted by each negative scene should be equal to the influence exerted by the positive scene it replaced. These results are consistent with the observational learning theories described by Miller and Dollard (1941), Mowrer (1960) and Bandura (1965).

Since training strategies caused differences in the teachers' behaviors, the behavior variance may have been the cause of the gains in pupil achievement. Though there were no significant differences in activity lesson teaching behaviors between positive and both positive and negative model analysis groups according to SLAS ratings, neither the quality nor the frequency of the appropriate behaviors was assessed. Perhaps the positive model group exhibited a higher frequency of the behaviors causing additional increases in pupil achievement. With pupil achievement two steps removed from the source of the variation (the training strategy), it is encouraging to be able to note a difference.

These results support the contention of Yeany (1977b) that pupil performance can and should be used to make judgments about the effectiveness of teacher training strategies.

Though it is an appealing idea that all preparation level teachers could be equally competent at exhibiting activity lesson behaviors, it may not be a realistic expectation since previous teacher training experiences are different for each level.

The results of the model analysis training were consistent across preparation levels, with the exception of the public school lesson introduction and equipment behaviors subcategories. This consistency is an important finding because it means that treatment can be applied at various training levels with similar expected outcomes.

The positive correlations found between pupil achievement and public school lesson teaching behaviors support the validity of the Science Laboratory Analysis System. The validity of the individual behaviors measured with SLAS as teacher behaviors which can affect student achievement in a science activity lesson is also supported by the positive correlations.

The small differences found between micro- and public school teaching, when all subjects were included in the analysis, suggest that micro-teaching may be used as an indicator of a teacher's ability to exhibit teaching behaviors in an actual classroom. The consistency of the model analysis groups' and the decrease in the control group's exhibition of behaviors between the micro- and public school lessons revealed when data were analyzed separately, supports the effectiveness of model analysis

training strategy.

This study offers empirical evidence to the trainers of preservice science teachers that model analysis training strategies can significantly influence the acquisition of teaching behaviors. Also, the positive correlations between SLAS teaching behaviors and pupil achievement support the contention that these are appropriate activity lesson behaviors. Therefore, it is possible for teachers' abilities to perform appropriate activity behaviors to be increased with a small expenditure of a trainer's time. Teachers could use model analysis materials either during or outisde of class, therefore increasing the flexibility of a training program.

Table 1

Generalizability Coefficients for
Teaching Behavior Measure

Teaching Behavior	ρ^2
Introduction	.92
Giving Directions	.86
Equipment	.72
Activity Management	.85
Summary	.83
Total Score (Overall)	.93

Table 2

Cell Means and Marginal Means Across Treatment and Preparation Levels for Total Teaching Behaviors Micro-Teaching Lesson

Group	Treatment: Control (c)	Positive and Negative (n)	Positive (p)	
Elementary (e)	14.60	21.40	22.70	$\bar{X}_e = 19.57$ $SD_e = 1.64$ $N_e = 15$
Middle School (m)	19.20	24.90	23.30	$\bar{X}_m = 22.47$ $SD_m = 3.57$ $N_m = 15$
Secondary (s)	13.83	23.64	22.50	$\bar{X}_s = 21.12$ $SD_s = 4.36$ $N_s = 13$
	$\bar{X}_c = 16.19$ $SD_c = 4.15$ $N_c = 13$	$\bar{X}_n = 23.35$ $SD_n = 2.32$ $N_n = 17$	$\bar{X}_p = 22.89$ $SD_p = 1.43$ $N_p = 13$	

Note: Maximum score = 28.

Table 3

Analysis of Variance Summary Table for
Total Teaching Behaviors:
Micro-Teaching Lesson

Source of Variation	df	ms	F	Probability of F
Treatment Group (TG)	2	222.50	36.11	0.000
Preparation Level (PL)	2	33.74	5.48	0.009
TG x PL	4	10.06	1.63	0.189
Error	34	6.16		

Table 4

Cell Means and Marginal Means Across Treatment and Preparation Levels for Total Teaching Behaviors: Public School Lesson

Group	Treatment: Control (c)	Treatment: Positive and Negative (n)	Treatment: Positive (p)	
Elementary (e)	11.80	21.90	24.60	$\bar{X}_e = 19.43$ $SD_e = 6.61$ $N_e = 15$
Middle School (m)	14.20	24.60	23.80	$\bar{X}_m = 20.87$ $SD_m = 5.77$ $N_m = 15$
Secondary (s)	11.67	22.42	21.50	$\bar{X}_s = 19.32$ $SD_s = 5.65$ $N_s = 11$
	$\bar{X}_c = 12.69$ $SD_c = 4.47$ $N_c = 13$	$\bar{X}_n = 22.94$ $SD_n = 2.54$ $N_n = 16$	$\bar{X}_p = 23.75$ $SD_p = 2.70$ $N_p = 12$	

Note: Maximum score = 28

(The number of subjects for all public school measures is two less than for all micro-teaching measures. Two subjects were unable to teach an activity lesson in the public school due to constraints of their individual field experience placement.)

Table 5

Analysis of Variance Summary Table for
Total Teaching Behaviors:
Public School Lesson

Source of Variation	df	ms	F	Probability of F
Treatment Group (TG)	2	505.04	44.48	0.000
Preparation Level (PL)	2	15.11	1.33	0.278
TG x PL	4	5.71	0.50	0.734
Error	32	11.36		

Table 6

Summary of F-Ratios for Effects of Model Analysis Training Strategy on Science Teaching Behaviors

Teaching Behaviors	F	Probability of F
Micro-Teaching Lesson		
Total	36.11	0.00
Introduction	13.55	0.00
Giving Directions	8.25	0.001
Equipment	11.04	0.00
Activity Management	15.67	0.00
Summary	16.42	0.00
Public School Lesson		
Total	44.48	0.00
Introduction	17.10	0.00
Giving Directions	27.65	0.00
Equipment	22.89	0.00
Activity Management	33.31	0.00
Summary	10.16	0.00

Table 7

Cell Means and Marginal Means Across Treatment and Preparation Levels for Pupil Achievement

Group	Treatment: Control (c)	Treatment: Positive and Negative (n)	Treatment: Positive (p)	
Elementary (e)	2.28	2.28	2.36	$\bar{X}_e = 2.31$ $SD^e = 1.64$ $N_e = 15$
Middle School (m)	0.44	1.86	1.84	$\bar{X}_m = 1.38$ $SD^m = 1.08$ $N_m = 15$
Secondary (s)	0.47	0.82	3.05	$\bar{X}_s = 1.13$ $SD^s = 1.05$ $N_s = 11$
	$\bar{X}_c = 1.15$ $SD^c = 1.83$ $N_c = 13$	$\bar{X}_n = 1.60$ $SD^n = 1.04$ $N_n = 16$	$\bar{X}_p = 2.26$ $SD^p = 1.03$ $N_p = 12$	

Table 8

Analysis of Variance Summary Table for the Effects of Training Strategy and Preparation Level on Pupil Achievement

Source of Variation	df	ms	F	Probability of F
Treatment Group (TG)	2	3.51	2.29	0.117
Preparation Level (PL)	2	4.96	3.23	0.053
TG x PL	4	2.23	1.45	0.240
Error	32	1.53		

Table 9

Summary of Pairwise Contrasts of Treatment Level Means by Pupil Achievement

Hypothesis	q	p
c = p	3.15	$\approx$ .12
n = p	1.96	> .10
c = n	1.36	> .10

c = control
n = positive and negative model analysis
p = positive model analysis

$.10q_{3,30} = 3.486$

$.10q_{2,30} = 2.888$

Table 10

Summary of F-Ratios for Effects of Preparation Level on Teaching Behaviors

Teaching Behaviors	F	Probability of F
Micro-Teaching Lesson		
Total	5.48	0.009
Introduction	2.09	0.140
Giving Directions	7.62	0.002
Equipment	5.70	0.007
Activity Management	1.48	0.242
Summary	0.38	0.685
Public School Lesson		
Total	1.33	0.278
Introduction	0.72	0.493
Giving Directions	1.70	0.198
Equipment	1.70	0.199
Activity Management	0.61	0.552
Summary	0.13	0.883

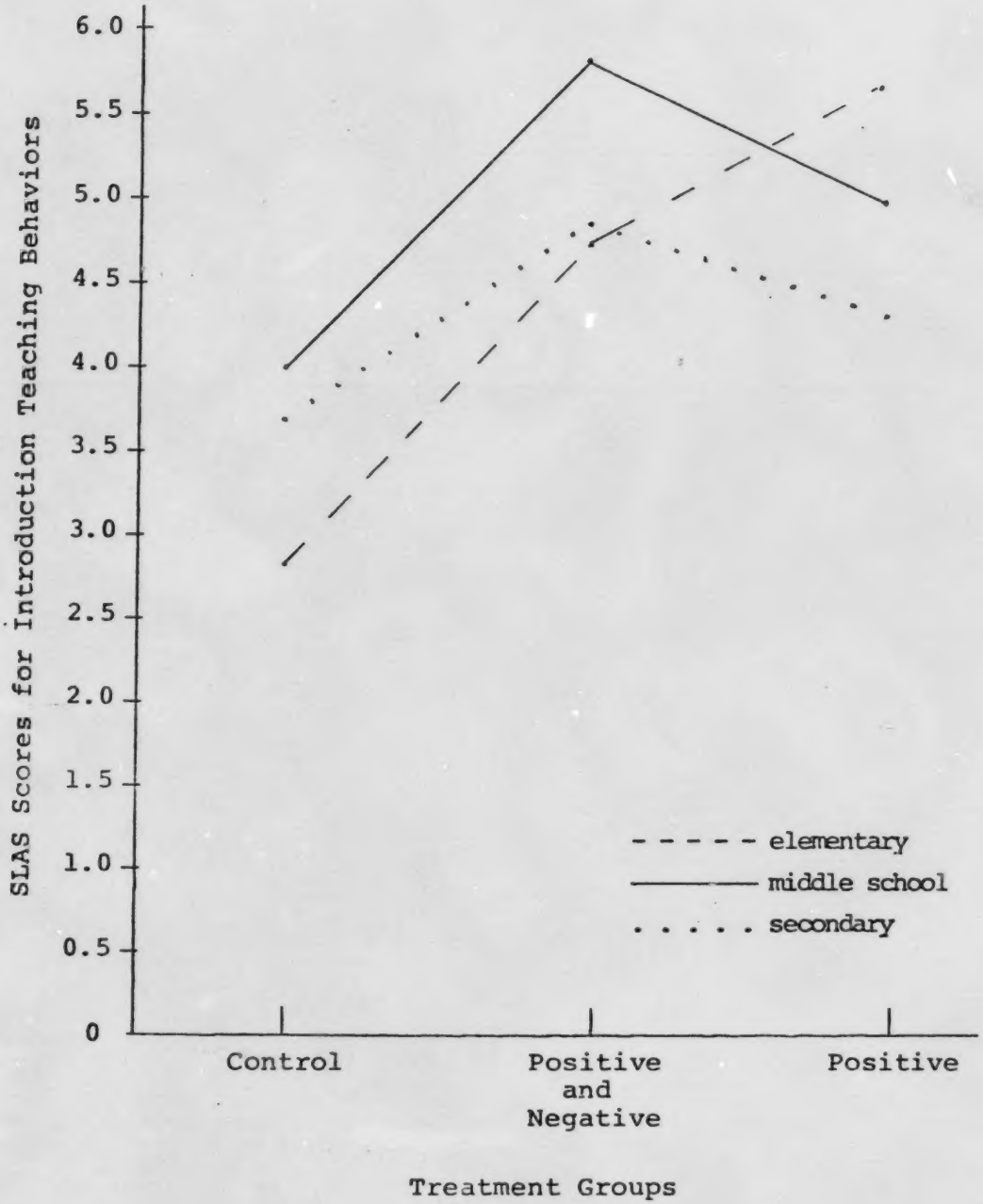

Figure 2. Interactions between training strategy and preparation level for micro-teaching introduction behaviors.

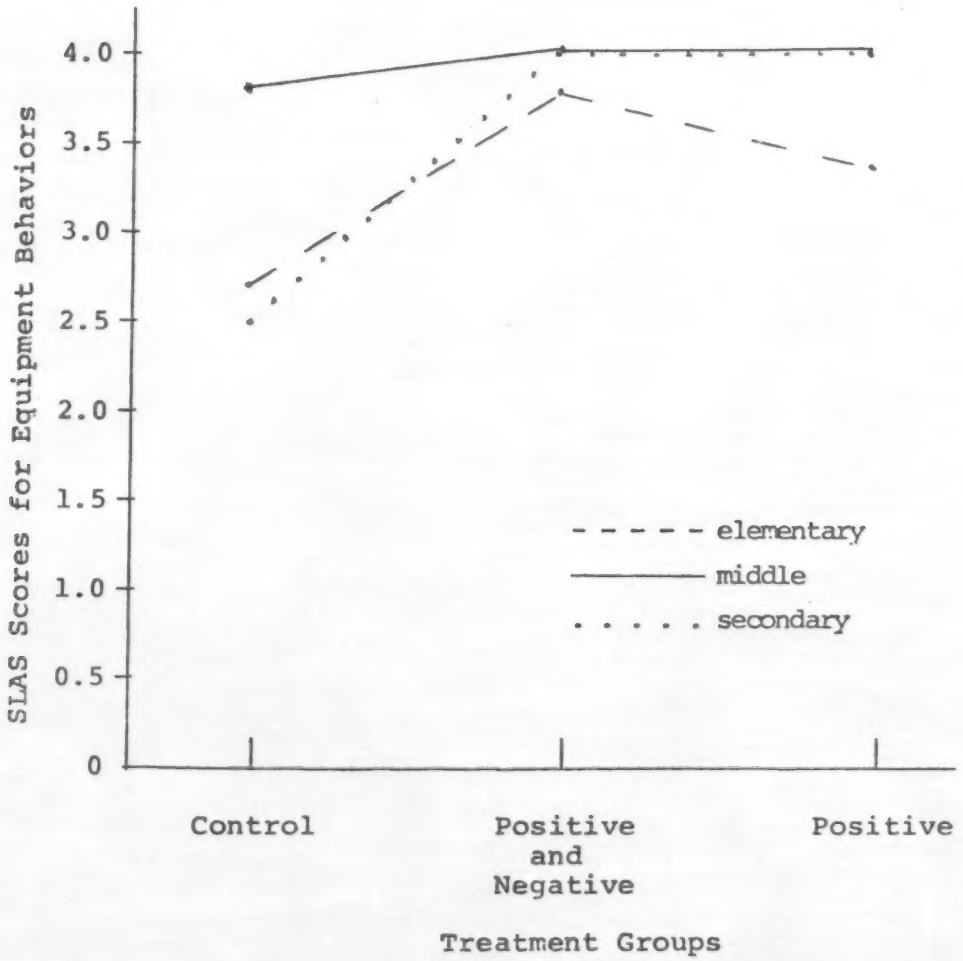

Figure 3. Interactions between training strategy and preparation level for micro-teaching equipment behaviors.

Table 11

Pearson Correlation Coefficients between Pupil Achievement and Public School Lesson Teaching Behaviors of Preservice Teachers

Teaching Behavior Category	r	p
Total SLAS Score	0.42	0.003
Sub-Category SLAS Score		
Introduction	0.35	0.012
Giving Directions	0.23	0.072
Equipment	0.48	0.001
Activity Management	0.39	0.005
Summary	0.34	0.016

Table 12

Summary of Correlated t Tests on Teaching Behaviors for Public School Lesson and Micro-Teaching Lesson

Teaching Behaviors	Micro-Teaching Lesson		Public School Lesson			
	$\bar{X}$	SD	$\bar{X}$	SD	t	p
Total	20.95	4.32	19.93	5.95	-1.70	0.10
Introduction	4.54	1.23	5.02	1.57	2.29	0.03
Giving Directions	3.52	1.12	3.68	1.30	0.92	0.36
Equipment	3.61	0.71	3.43	0.95	-1.47	0.15
Activity Management	6.22	1.07	5.54	1.64	-3.52	0.01
Summary	3.06	1.38	2.26	1.58	-3.53	0.01

Note: N = 41

Table 13

Summary of Correlated t Tests on Control Group Teaching Behaviors for Public School Lesson and Micro-Teaching Lesson

Teaching Behaviors	Micro-Teaching Lesson		Public School Lesson			
	X	SD	X	SD	t	p
Total	16.19	4.15	12.69	4.47	-2.80	0.016
Introduction	3.46	1.20	3.50	1.49	0.08	0.936
Giving Directions	2.73	1.20	2.23	1.11	-2.45	0.031
Equipment	3.08	0.89	2.42	1.08	-2.34	0.037
Activity Management	5.23	1.15	3.62	1.49	-4.16	0.001
Summary	1.69	1.38	0.92	1.38	-1.69	0.117

Note: n = 13

Table 14

Summary of Correlated t Tests on Model Analysis Groups' Teaching Behaviors for Public School Lesson and Micro-Teaching Lesson

Teaching Behaviors	Micro-Teaching Lesson		Public School Lesson			
	$\bar{X}$	SD	$\bar{X}$	SD	t	p
Total	23.16	2.02	23.29	2.59	0.22	0.824
Introduction	5.04	0.89	5.73	1.01	3.21	0.003
Giving Directions	3.89	0.89	4.36	0.69	2.19	0.037
Equipment	3.86	0.45	3.89	0.32	0.33	0.745
Activity Management	6.68	0.66	6.43	0.63	-1.47	0.152
Summary	3.70	0.82	2.88	1.26	-3.10	0.004

Note: n = 28

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